Stroke Rehabilitation Intensity Literature Review

Topic Description and Rationale for Choosing the Topic:

Providing effective levels of therapy is a major concern post stroke. Patients spend 60% of their day alone and only 13% of their day on therapeutic activities (Bernhardt et al., 2004). We know that the earlier therapy starts the better (Kalra et al., 1994). There is a positive relationship between scheduled therapy time and outcomes (Lohse et al., 2014) and higher intensity therapy is associated with better outcomes and reduced length of stay (Jette et al., 2005). There is a significant relationship between therapeutic duration and functional outcomes – significantly better for those receiving 3 to 3.5 hours of therapy per day (Wang et al., 2013).

Rehabilitation Intensity is defined as:

"An individualized treatment plan involving a minimum 3 hours of direct task-specific therapy per patient per day by the core therapies, for at least 6 days a week".

"Face-to- face treatment provided by an occupational therapist (OT), physiotherapist (PT), speech-language pathologist (S-LP), occupational therapy assistant (OTA), physiotherapy assistant (PTA) and communicative disorders assistant (CDA)" (Ontario Stroke Network, 2014).

Recently the Ontario Stroke Network Rehabilitation Intensity (RI) Working Group was tasked with developing a literature review that would provide information and background for clinicians on why RI provision is important. We will be using the evidence from the literature to support implementation of increasing RI for stroke patients and to identify future directions for research.

What Will the Review Add to the Current Practice in the Health Care Setting?

This literature review will facilitate an informed investment by hospital and community stakeholders into RI provision. Furthermore, the literature will identify how RI relates to functional outcomes, and perhaps processes that can be put in place to increase RI or identify the barriers which prevent it.

Questions that Guided this Search

Population: Stroke survivors 18+ receiving inpatient rehabilitation treatment

Intervention: OT, PT, S-LP, OTA, PTA, Rehabilitation Assistant, and CDA.

Control: No intervention

Outcomes: Improved functional outcomes, reduction in rehabilitation length of stay (LOS), and successful discharge to home

Question: Does increased participation in or provision of occupational therapy, physiotherapy, speech-language pathology therapies improve functional outcomes and/or reduce LOS as well as improve chances of discharge to home in adult stroke survivors treated within an inpatient active rehabilitation setting?

Search Strategy:

Limits placed on the search:

Human only, age 18+ (no pediatric stroke), English articles, articles from the year 2000 onwards, interventions that included OT, PT, S-LP (or assistants) or referred to rehabilitation therapy.

Databases:

Included databases that contain allied health information, explored databases from Europe, and looked at systematic reviews: CINAHL, Cochrane, OVID/Medline and Embase.

Search terms:

Population	Intervention	Comparison	Outcome
Adult stroke survivors in inpatient active rehabilitation	OT, PT, S-LP, OTA/PTA, CDA, *recreation therapy, *circuit training, *group therapy	No intervention, *group therapy, * circuit training, *recreation therapy	Improved functional outcomes, reduced LOS, discharge to community, discharge to home
Stroke, stroke patient, stroke lacunar, intracranial hemorrhage, cerebral ischemia, cerebral hemorrhage	Physiotherapy, occupational therapy, speech-language pathology, recreation therapy, therapeutic recreation, exercise, muscle strengthening, cognitive training, balance training, gait training, ADL training, communication training, UE training (*training can be exchanged with treatment)	No intervention, circuit training, group therapy, recreation therapy	Functional gains, functional improvement, reduced LOS, improved FIM™, improved Barthel, discharge destination, discharge to home, increased independence, improved motor function, improved cognitive function, improved communication

Inclusion and Exclusion Criteria of Selected Studies:

We also included RCT studies from January 1, 2000 to May 23, 2012 that were already reviewed/covered by the Health Quality Ontario review completed by Sehatzadeh, S. (Effectiveness of Increased Intensity of Rehabilitation in Post-Stroke Patients: A Rapid Review, March 2013).

The intervention must include provision of therapy by at least one of OT, PT and/or S-LP or in comparison group therapy or circuit therapy training.

Studies including patients under 18 were not reviewed. Studies on non-humans were not reviewed.

We included additional rationale for increased RI beyond improved functional outcomes, decreased LOS or discharge to home. These may be (together or in isolation): improved balance, decreased depression, improving gait/walking, improved cognition, and/or improved communication.

After initial search, the reference list of all included articles was reviewed. Studies which were referred to or referenced in more than 2 studies were then sought out and reviewed for inclusion even if they were outside the 10 year time limit initially set.

Review of Articles:

Top articles were reviewed by the subcommittee and broken down as follows to provide synopsis:

1. Sample

2. Study Design and Purpose of the Study

3. Underlying Components of RI if Included: Staff Mix/Providers, Intensity and Duration of Therapies Provided, Format of Therapy (Methods)

4. Outcome Measures

5. Results

6. Comments based on critical appraisal that considered the following questions: Randomization? Group similar? Blind participants? Blind assessors? Adequate follow up? Intention to treat? Between group comparison? Point and variability measures? Sample size can detect change? External validity?

Articles were broken into groups of 10 and assigned to reviewers from the Rehabilitation Intensity Literature Review Subcommittee and then all articles were re-reviewed by one member before final compilation. Articles were initially colour coded according to the Level of Evidence adapted from the Oxford Centre for Evidence Based Medicine 2011. Levels of Evidence are as follows: Level 1: Systematic Reviews and Randomized Control Trials; Level 2: Inception Cohort Studies; and Level 3: Observation Study with Dramatic Effect or Retrospective Chart Review. Although attempting to focus on the inpatient rehabilitation setting several studies were found that related to stroke patients in other settings or moment of time throughout their stroke care continuum. These were included and then separated out to identify that the setting was in fact NOT inpatient rehabilitation.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
			Staff Mix/Providers	Intensity and Duration	Format of Therapy			
Randomized Control Trials where study occurred in the inpatient rehabilitation setting.								
Blennerhassett, J. & Dite, W. (2004). Additional task-related practice improves mobility and upper limb function early after stroke: a randomised controlled trial. Australian Journal of Physiotherapy, 50(4), 219-24.	n = 30 Time since stroke onset:? Functional Status:? Inclusion criteria: inpatients who had the ability to walk 10 m with close supervision (with/without gait aids), and could provide consent. Excluded: Patients with deteriorating medical condition and/or independent community ambulators.	Prospective Randomised Single Blind Clinical Trial Purpose: to determine if patients would make greater functional gains in the area which they received additional practice. Patients were assigned randomly to the Upper Limb or Mobility Group.	PT	All subjects received usual rehab (1 hour of PT, 5 days/wk) and an additional session of task related practice (1 hour per day, 5 days/wk, for 4 weeks) in a circuit class format. The additional circuit training consisted of 10 five-minute work stations. The duration of interdisciplinary therapy was recorded and PT time related to mobility and upper limb tasks was recorded.	Both Mobility and Upper Limb group sessions consisted of a circuit of 10 five-minute workstations with up to 4 subjects in each session. Groups supervised by PT; all activities were customised and progressed to suit individual subjects. The Mobility classes were conducted separately from the Upper Limb sessions. Page 220 details all activities for the 2 groups.	Upper arm: -Jebson Taylor Hand Function Test (JTHFT) -2 arm items of the Motor Assessment Scale (MAS) -Timed Up and Go -Step test -Six Minute Walk Test Assessment times: initial test, 4-week follow-up and 6-month follow-up.	Additional task related practise effective in improving functional outcomes. Trend towards the Mobility Group having a shorter rehab stay (days between commencing study and discharge (p=0.05) and total length of rehab (p=0.05)). At 6 months there was no significant difference between the 2 groups. Larger gains were seen in both groups that were specific to the type of additional practise received. Both groups improved significantly between pre and post-tests (at 4 weeks) on the mobility measures, more gains seen in the Mobility Group. Only the Upper Limb Group made significant improvement on the upper arm items (JTHFT and MAS).	Sample of stroke patients relatively young (only 4 subjects from each group were over 65) - therefore findings may not be generalizable. Loss of power on UE testing as 1/3 of subjects in each group were unable to perform the hand dexterity test. No control applied between completion of study intervention and 6 month follow up. This study focused on increasing intensity via circuit training vs. individualized therapy.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Burgar, C.G. et al. (2011). Robot-assisted upper limb therapy in acute rehabilitation setting following stroke: Department of Veterans Affairs multisite clinical trial. Journal of Rehabilitation Research and Development, 28(4), 445-58.	n = 54

Time since stroke onset: 7-21 days post stroke

Functional Status:?

Inclusion criteria: veterans admitted to acute inpatient rehabilitation setting.

Excluded: patients with upper limb joint pain that restricted normal movement, with absent proprioception or with MMSE under 22. | Prospective Randomized Control Trial.

Multi-site study with outcome raters blinded to group assignment.

Purpose: conventional therapy compared to two different doses of robot-assisted therapy to determine if robot-assisted therapy can facilitate greater motor recovery when compared to the same amount of early hands-on therapy and to assess the dose-response relationship. | OT and PT provided the treatment; staffing levels not indicated. | 15 one-hour therapy sessions over a 3-week period for robot low dose and conventional therapy group.

30 one-hour therapy sessions over the same period for robot high dose group.

In addition to research treatment time, regular PT, OT and S-LP were also provided (minimum of 2 hours per day for at least 5 days per week). | 3 groups:

1) Mirror Image Movement Enabler (MIME) robot therapy - low dose.

2) MIME–high dose

3) Early hands-on conventional therapy | Fugl-Meyer Assessment (FMA) of the upper limb

MMT of 14 shoulder and elbow muscle groups (using the Medical Research Council Motor Power Grading Scale)

Upper limb portion of the FIM™

Modified Ashworth Scale

Wolf Motor Function Test | Secondary analysis of intensity of training found even stronger correlation between average number of hours of therapy per day and the FMA changes at the end of active treatment and at 6 months.

Robot-assisted (RA) therapy training did not result in significant advantage over equal amount of practise with a therapist.

Robotic devices are more likely to be widely accepted if they can be used to increase the intensity and dose beyond what is practised with therapist assistance and to do so in a cost effective manner. | Effect of dose on response was a secondary outcome measure.

Study had small number of subjects in each group and varied in severity levels across subjects.

Group differences in age were significant (Robot high dose therapy group had younger subjects).

Wide spread in treatment dose provided to robot-trained subjects -few received the maximum allowed for various reasons. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Glasgow Augmented Physiotherapy Study (GAPS) Group. (2004). Can augmented physiotherapy input enhance recovery of mobility after stroke? A randomized controlled trail. *Clinical Rehabilitation*, 18(5), 529-37.

 * also in Sehatzadeh HQO Rapid Review. | n = 70

Time since stroke onset: within the last 6 weeks.

Functional Status: able to benefit from and tolerate mobility rehabilitation.

Inclusion criteria: patients admitted to one of three rehabilitation facilities with a diagnosis of stroke.

Excluded:? | Randomized Control Trial (multi-site study)

Purpose: to determine if additional inpatient PT after stroke speeds recovery of mobility. Intervention group received additional PT time (60-80 min/day) over conventional PT group. | Focused on PT povision of treatment. No difference in staff grade of type (skill mix) between the two groups. | Standard Treatment Group: Conventional PT, 30-40 minutes, 5 days per week.

Augmented Group: standard PT as above plus additional PT of 60-80 minutes per day, 5 days per week.

Both groups had normal access to other interventions (OT, nursing, etc.).

On average the number of treatment hours per weekday between augmented and standard group differed by 0.45 hours (62 vs. 35 minutes per day). | Treatment broadly based on normal movement (Bobath); included dynamic sitting balance, standing balance, UE function, walking, and other functional mobility tasks.

Standard Group received on average 5 hours of upper limb training, 5 hours of lower limb training, and 11 hours of other work. Total=21 hours.

Augmented Group received 10 hours of upper limb work, 9 hours of lower limb work, and 15 hours of other work. Total=34 hours. | Rivermead Mobility Index, type and amount of treatment, patient activity, Trunk Control Text, Motricity Index, Barthel Index, Nottingham Extended ADL Score, LOS, and Complications. | Overall intervention did not provide significant changes in the outcome measure of mobility, ADL, or patient quality of life.

Mean proportions of time spent standing and walking was greater in the augmented group.

Augmented group also more active with greater proportion of time spent standing or walking up until 4:30 pm.

Mean LOS from the Augmented group was 45 days, and mean LOS for the standard group was 54 days; difference between groups was not statistically significant. | Assessors were blinded.

Additional therapy carried out by usual therapy staff.

Trial was relatively unpowered to detect modest changes in outcome.

Study was constrained by limited resource for provision of augmented therapy. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)		Main Outcome Measures	Results	Comments
Kwakkel, G. et al. (2002). Long term effects of intensity of upper and lower limb training after stroke: a randomised trial. Journal of Neurology Neurosurgery and Psychiatry, 72(4), 473-9. * also in Sehatzadeh HQO Rapid Review.	n = 101 Time since stroke onset: within 14 days. Functional Status: severely disabled patients; MCA Stroke; 30-80 years old; impaired motor function of UE and LE; unable to walk at first assessment; able to provide consent; and admitted to hospital in the acute and subacute rehabilitation phases. Excluded: complicated medical history; communication deficits.	Randomized Control Trial Purpose: to assess long term effects at one-year post stroke in patients who participated in upper and lower limb high intensity training program vs. control group.	Does not indicate who was poviding the training.	Patients randomly assigned to one of three groups: 1) Arm training group: received arm training for 30 minutes/day, 5 days per week for 20 weeks. 2) Leg training group: received leg training for 30 minutes/day, 5 days per week for 20 weeks. 3) Control group: arm and leg were immobilized for 30 minutes/day, 5 days per week for 20 weeks. All 3 groups received 15 min of LE rehabilitation, 15 min of UE rehabilitation, and 1.5 hour of ADL training daily.	Task oriented therapeutic approach used. Upper limb treatment focused on grasping, reaching, and leaning. Lower limb treatment focused on functional recovery of balance, transfers, turning over, and gait. After the 20-week protocol the upper limb group received 3860 minutes (2250 minutes more than control group). The lower limb group received 3660 minutes (2320 minutes more than control group).	Barthel Index Action Arm research test (ARAT) and Functional Ambulation Categories (FAC) Walking speed (10 min times walk test) Part 1 of the Nottingham Health Profile Short version of the Sickness Impact Profile	Overall higher intensity of upper and lower limb function training during the first 6 months after stroke did not result in significant gains at one year. At 20 weeks the leg training group showed a small significant improvement when compared to the control group (p<0.05), which was not maintained at 26 weeks, 38 weeks or 1 year (for both arm or leg training groups).	More than ½ the patients did not receive any further therapy beyond 6 months post stroke. Possible observation bias in the study due to elimination of blinding the observer 6 months after stroke.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Outermans, J. et al. (2010). Effects of high- intensity task-oriented training on gait performance early after stroke: a pilot study. Clinical Rehabilitation, 24, 979-987.	n = 44 Time since stroke onset: 2-8 weeks Functional Status/ inclusion criteria: Inpatients at the neurorehabili-tation clinics in Bad Berleburg, Germany; able to walk 10 metres without assistance. Excluded: cardiovascular instability; acute impairment of the LE; and sensory or communicative disorders.	Randomized Control Trial – pilot study Purpose: to investigate effects of high intensity task-oriented training on gait by comparing the high intensity exercise program to the lower intensity exercise program.	PT	All participants received usual PT for 30 minutes each day. The high intensity task-oriented training group performed 45 minutes of circuit training 3 times per week for 4 weeks. This included 10 workstations with all stations involving 2.5 minutes of practice. At the end, 10 minutes was spent on walking relays and races. Low intensity group received a 45-minute program of group exercises, three times a week for 4 weeks using a workstation format.	High intensity group: Circuit focused on posture control and gait-related activities such as stair walking, turning, transfers, walking quickly and walking distances. Number of reps and workload (based on HRR) was progressed based on the therapist's observations and patient's perceived rate of exertion (using the 6-20 Borg Scale of Perceived Exertion). Low intensity group: Focus was on improving motor control of the hemiparetic leg and balance.	Six-minute walk test RPE (Borg) 10 Metre Timed Walk Test Berg Balance Scale Functional Reach Test.	No difference in change in balance between groups. Walking distance and gait speed were significantly better in the high intensity training group. Content of the intervention differed in that the higher intensity practice included high cardiorespiratory workload, which may be responsible for favorable effects.	Observers were not blinded to group assignment. Subjects were functioning at a fairly high level at baseline.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Inception Cohort Studies which occurred in the inpatient rehabilitation setting								
Bode, R. K. et al. (2004). Relative Importance of Rehabilitation Therapy Characteristics on Functional Outcomes for Persons with Stroke. Stroke, 35, 2537-42.	n = 228 Time since stroke onset:? Functional Status/ inclusion criteria: >18 years of age; first stroke; receiving multi-disciplinary inpatient rehabilitation in an acute or subacute setting. Excluded: those with atypical LOS (less than 1 week and greater than 8 weeks).	Observational Study using data from 2 previous multicentre studies. Purpose: to evaluate the relative importance of therapy focus, intensity and LOS on functional gain. Compared function-focused to impairment-focused therapy.	PT, OT and S-LP.	Function-focused therapy vs. impairment-focused therapy recorded in units provided per day (1 unit = 15 minutes).	OT, PT and S-LP provided therapies classified into 5 areas: evaluation and screening, function-focused activities, impairment-focused activities, discharge planning, and case management.	FIM™ Units of time spent by OT, PT and S-LP in 71 pre-identified therapy activities	Longer stays and more intense function-focused therapy were associated with greater than expected gains in self-care and mobility. More impaired persons received more function-focused therapy. Time spent in impairment- focused activities was not associated with greater than expected improvement.	Therapy intensity accounted for a significant portion of the variance in residual functional change suggesting content and amount of therapy are both important aspects. Study used Residual Change Scores rather than raw gain (these are relative scores and not absolute scores).

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
De Wit, L. et al. (2007). Motor and Functional Recovery after Stroke. A comparison of 4 European rehabilitation centres. Stroke, 38, 2101-2107.	n = 463\n\nTime since stroke onset:?\n\nFunctional Status/ inclusion criteria: inpatient rehab setting; first stroke; 40-85 years old; Rivermead Motor Ax: Gross Function - 11, Leg/Trunk Fx8 and/ or Arm Function 12 on admission.\n\nExcluded: other neurological impairments; admission to centre more than 6 weeks post stroke; no informed consent; Barthel <50.	Observational Cross-Site Study\n\nPurpose: to assess variation in motor and functional recovery patterns for 6 months post stroke – including time spent in therapy.	As per CERISE trial but not specifically indicated in this article.\n\nDifference in therapy time in the study was not attributable to differences in patient/ staff ratio. UK site had higher nurse to patient staff ratios.	Average daily therapy time:\n\nUK = 1 hr/day\n\nBelgium = 2 hr/day\n\nGerman = 2 hr 20 min/day\n\nSwiss= 2 hr 46 min/day	OT, PT and S-LP provision as well as leisure activities in German centre. Otherwise content of therapy was similar in all 4 centres.\n\nNursing care in UK site more in line with 'rehabilitative nursing'.	Assessed using outcome measures at 2, 4 and 6 months.\n\nRivermead Motor Assessment of Gross Function, Leg/Trunk and Arm, Barthel Index (BI), and Nottingham Extended Activities of Daily Living.	Higher amount of therapy in German and Swiss centres resulted in better gross motor and functional recovery. The amount of therapy provided at these sites was due to the efficiency of the reorganization of services that included an emphasis on direct vs non-direct therapy time.\n\nGross motor and functional recovery was better in Swiss and German centres than in the UK center with the exception of personal self-care recovery in the UK.\n\nBetter NEADL scores found in the Swiss centre may be attributed to significantly higher OT input.\n\nThe most gross motor recovery was found in the German centre where patients spent less time passively.	Difference in timing of baseline assessment between centres made straight-forward comparison of recovery patterns between centres difficult.\n\nResearcher trained in assessments and collected all data, which was reviewed by project manager for re-calibration if necessary.\n\nConfounders were found to be non-significant.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Horn, S. et al. (2005). Stroke Rehabilitation Patients, Practice and Outcomes: Is earlier and more aggressive therapy better? Archives of. Physical Medicine & Rehabilitation, 86(2), S101-114.	n = 830 Time since stroke onset:? Functional Status/ inclusion criteria: post stroke rehabilitation patients; >18 years; moderate to severe stroke from the Post Stroke Rehabilitation Outcomes Project Database (PROP). Excluded: ?	Prospective Observational Cohort Study Purpose: to determine how specific rehabilitation therapies relate to outcomes, taking into account patient covariates.	Study looked specifically at PT, OT and S-LP therapy contributions.	Not applicable.	Not applicable.	Discharge total motor and cognitive sub scores on the FIM™ Discharge destination Time spent providing therapy from point of care intervention documentation	Earlier and more aggressive therapy is better, even with lower level functioning patients. More minutes per day spent in PT gait activities, OT upper extremity control and home management activities, and S-LP problem solving activities were associated with higher discharge FIM™ scores and greater rates of discharge to home.	Study used baseline FIM™ and CSI scores to control for patient differences (that otherwise would be addressed through randomization). Therapeutic activities that were productive or unproductive were identified but will need to be confirmed through validation studies (need to determine predictive validity of this study).

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Keren, O. et al. (2004). Relationship between rehabilitation therapies and outcome of stroke patients in Israel: a preliminary study. Israel Medical Association Journal, 6(12), 736-41.	n = 50; mean age 63 years Time since stroke onset: median 14 days, range 3-51 days. Functional Status/ inclusion criteria: patients hospitalized at one rehab centre in Israel; first stroke confirmed on MRI or CT; age >18 years. Excluded: LOS < 2wks; transfer out of rehab > 30 days.	Prospective Descriptive Study from Sept 1997 to May 1998 Purpose: to evaluate the effectiveness of inpatient rehab for post-acute stroke patients and examine the relationship between therapy intensity and functional status at discharge.	OT, PT, and S-LP. n=49 (OT) n=49 (PT) n=13 (S-LP)	Page 738 (Figure 2) shows the distribution of therapy intensity with each of the stroke patients in 15 min units per length of stay day.	The usual treatment consisted of daily sessions, 5 days a week, for every therapeutic modality deemed necessary. Patients were reassessed every 2 to 3 weeks and changes were made to the treatment plan accordingly.	-MMSE -Stroke Impairment Assessment Set -NIHSS -FIM™ -Rehab Institute of Chicago Functional Assessment Scale (RIC-FAS) For each discipline, various items (10 to 15) from the above tools were selected.	The intensity of OT was positively correlated with motor and cognitive gains – greater intensity equaled greater gains. Intensity of PT and S-LP was not significantly correlated with any measure of gain. Increased patient activity was positively correlated with therapeutic interventions. Improvements in impairment severity were not related to therapy intensity for any discipline.	Relatively small sample size with patients from only one centre - results cannot be generalized to whole populations of stroke patients.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
McNaughton, H. et al. (2005). A comparison of stroke rehabilitation practice and outcomes between New Zealand and United States facilities. Archives of Physical Medicine & Rehabilitation, 86(12), 115-20.	n = 1161 (Consecutive convenience sample of patients from 6 U.S. IRFs) AND n = 130 (patients in 1 NZ IRF after acute stroke) Time since stroke onset:? Functional Status/ inclusion criteria:? Excluded:? (Authors indicate to see Gassaway et al. (2005) for detailed description of patient selection criteria)	Comparative Study Purpose: to compare stroke rehab practice and outcomes in NZ and US including comparing therapy input (intensity) from OT and PT.	OT and PT.	The mean rehabilitation LOS was significantly shorter for U.S. participants (18.6 days vs 30.0 days) but during that time, more time was spent with a physiotherapist (U.S. mean of 800 min. vs NZ mean of 460.1 min.) and occupational therapist (U.S. mean of 715.0 min. vs NZ mean of 208.4.min.). U.S. participants were seen by a PT and OT on a larger proportion of the days that they spent in the rehabilitation facility.	Overall, NZ therapists spent more time in assessment and nonfunctional activities than their U.S. counterparts.	Discharge location FIM™ change	U.S. participants had more intensive 'treatment-focused' input from OT and PT with better and more rapid outcomes (as evidenced by increased FIM™ change and end scores) and lower chance of discharge to institutional care. These differences occurred despite the increased severity of U.S. participants' disabilities at the time of their rehabilitation admissions. Rehabilitation services that manage people with stroke should consider the level of intensity of therapy input and concentrate on active therapy.	Age disparity noted between US and NZ subjects with the NZ subjects representing an older cohort of stroke patients – age disparity may suggest unmeasured covariate in outcome.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Sonoda, S. et al. (2004).

Full-time integrated treatment program, a new system for stroke rehabilitation in Japan: comparison with conventional rehabilitation. American Journal of Physical Medicine & Rehabilitation, 83(2), 88-93.

* also in Sehatzadeh HQO Rapid Review. | n = 257

Time since stroke onset: 30-80 days since stroke onset to admission to rehabilitation.

Functional Status/ inclusion criteria: FIM™ motor sub score <=80; FIM™ cognitive sub score >=25

Excluded: patients with multiple strokes, brainstem or cerebellar lesions; recurrence of stroke or hip fracture during study; comorbidity index of >=14 at admission. | Comparative Study

Purpose: to validate effectiveness of the FIT program (full time integrated treatment) where rehabilitation is provided 7 days/week with increased daytime activity and enhanced communication by comparing conventional therapy to those receiving FIT therapy as well. | PT, OT, and

S-LP | Conventional Group: 40 min of PT and 40 min of OT per day, 5 days/wk; speech therapy 5 day/wk if necessary (duration not specified).

FIT Group: 2 additional days of OT and PT sessions per week were added with duration remaining the same: 40 min of PT and 40 min of OT per day, 7 days/wk; speech therapy sessions were similar to the Conventional Group.

In this study, 'intensity' refers to the amount of exercise and activity within a day and 'frequency' refers to the days of exercise per week. | Conventional Group (n=131): therapy focused on gait and exercise related to ADLs, orthoses if necessary, PROM of the affected side and muscle strengthening exercise of the unaffected side. Speech therapy was provided if necessary.

FIT Group (n=126): in addition to therapy described above patients were encouraged to stay out of the sleeping area during daytime and to freely ambulate in the corridor and to speak and interact with one another instead of lying in bed. Self-initiated exercise such as standing and walking under the nurse's supervision was performed. Patients were to perform their self-care activities as independently as possible | FIM™ instrument scores (translated into Japanese)

LOS | Statistical significance was found between the 2 groups with the FIT program attaining a higher discharge FIM™ level with a shorter LOS.

The level of improvement in ADLs that was reached at 6wks through conventional exercise was reached within 4 wks with the FIT program.

The motor sub scores of the FIM™ at admission and discharge were 64.3 and 77 in the conventional group vs 60.6 and 80.9 in the FIT group.

The LOS and FIM™ efficiency was 80 days and 0.16 in the conventional group and 69.8 and 0.30 in the FIT group.

See Table 2 on page 91 for all results. | Days from onset to admission very delayed in this study. 54.1 +/- 13.5 and 49.8 +/- 12.6 and the LOS 70 to 80 days. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)		Main Outcome Measures	Results	Comments
Observational Studies with dramatic effect and/or Retrospective Chart Reviews in the inpatient rehabilitation setting							
Foley, N. et al. (2012). Inpatient rehabilitation following stroke: amount of therapy received and associations with functional recovery. Disability & Rehabilitation 4(24), 2132-2138.	n = 123 (mean age 67 years) Time since stroke onset: number of days from stroke onset to rehab admission: Mean = 33, Median= 16 Functional Status/ inclusion criteria: stroke patients on inpatient rehabilitation unit; patients that resided at home prior to stroke. Excluded: ICD-10 code G45 (TIA).	Retrospective Design Purpose: to determine if one hour per day per therapy standard is met and if amount of therapy is an independent contributor to functional improvement. Correlated therapy input time (through workload measurement) with FIM™ gains.	PT, OT, and S-LP. 30-bed unit 4.5 FTE OT 4.5 FTE PT 1.0 FTE OTA 1.0 FTE PTA 1.6 FTE S-LP Time spent in assessment, consultation or treatment can be seen in Table II of the article, p.2134.	Patients were engaged in therapeutic activities for an average of 37 minutes per day with both OT and PT, and 13 minutes per day with S-LP. Total time of therapy, assessment and consultation combined was 58.6 minutes for PT, 54.4 minutes for OT and 19.2 minute for S-LP per day. In total, 67-74% of therapists' time were spent engaged in therapeutic activities with the patient.	Not indicated.	FIM™ change. Workload measurement data Demographic data Time from stroke onset to rehab admission and active length of stay	Admission FIM™, LOS and OT and PT therapy time (hrs) were significantly correlated with FIM™ gain. In the final model, which explained 35% of the variance, admission FIM™ score and total amount of occupational therapy (OT) emerged as significant predictors of FIM™ gain. Admission FIM™, length of stay, as well as total OT and PT therapy time (hrs) provided were significantly correlated with FIM™ gain.	Therapy time captured using self-report vs. therapy time confirmed by an independent party. Therapists failed to provide the minimum standard of one hour per day as suggested by the CBPR which may have been due to staff absences and lack of replacement.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Jette, D.U. et al. (2005). The relationship between therapy intensity and outcomes of rehabilitation in skilled nursing facilities. Archives of Physical Medicine & Rehabilitation, 86(3), 373-379.	n = 9537 933 admitted to skilled nursing facilities (SNF) with stroke; 2896 with orthopedic conditions, amputation or arthritis; 1099 with cardiovascular & pulmonary conditions. Time since stroke onset: 781 were <1 week from stroke onset upon admission to SNF. Functional Status: Mean Admission FIM™ = 56.2. Inclusion Criteria: in short term rehab at a SNF Excluded: died during SNF stay; LOS >100 days; average of more than 4 hours/day of any 1 type of therapy.	Retrospective Design Purpose: to examine relationship between therapy intensity (PT, OT and S-LP) in a skilled nursing facility on patient outcomes (LOS and FIM™).	PT, OT, and S-LP	Subdivided into 3 categories: Group 1: 0.25−0.50 hours a day Group 2: 0.51−0.75 hours a day Group 3: >0.75 hours a day per discipline	Not indicated	FIM™ LOS	Higher therapy intensity was associated with shorter LOS (for stroke) and improvements in patient functional independence. Higher PT and OT intensities were associated with greater odds of improving by at least 1 stage in mobility and ADL functional independence across each condition. The OT intensity was associated with an improved executive control for patients with stroke. The S-LP intensity was associated with improved motor and executive control for patients with stroke.	Study based on secondary data.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Karges, J. & Smallfield, S. (2009). A description of the outcomes, frequency, duration, and intensity of occupational, physical, and speech therapy in inpatient stroke rehabilitation. Journal of Allied Health, 38(1), e1-10.	n = 80 Time since stroke onset:? Functional Status/ inclusion criteria: stroke patients; aged 18-85 years; OT and PT inpatient rehabilitation intervention documented; FIM™ scores documented; those who completed rehab stays. Excluded: patients with CHF, MI, unremitting cardiac arrhythmia, pneumonia, hip fracture and DVT.	Non-Experimental Retrospective Design Purpose: to describe outcomes, frequency, duration and intensity of therapeutic intervention in the inpatient rehabilitation setting.	OT, PT and S-LP provided but ratios of staff to patients not provided.	OT, PT, and S-LP for 30 minutes per session, 1.5 times per day, 5 to 6 days per week on average. The mean number of minutes of therapy each day was 51.38 for OT, 48.01 for PT, and 41.39 for S-LP for a total average of 2.35 hours of therapy per day. Mean number of therapy sessions per subject was 21.73 ± 18.11 for OT, 21.99 ± 18.10 for PT, and 18.86 ± 18.71 for S-LP. Mean number of sessions per day was 1.72 ± 0.31 for OT, 1.65 ± 0.36 for PT, and 1.52 ± 0.48 for S-LP. Mean number of minutes provided per session was 29.87 ± 1.77 minutes for OT, 29.70 ± 1.65 minutes for PT, and 27.23 ± 6.64 minutes for S-LP.	Study looked at content of therapy sessions as follows: 1) evaluation, 2) evaluation and intervention, 3) re-evaluation and intervention, 4) re- evaluation, 5) co-treatment, 6) discipline specific and co-treatment, 7) group intervention, and 8) home evaluation. Inpatient rehab LOS was just over 2 weeks on average.	FIM™ scores, LOS, and discharge location. Demographic data, subject characteristics, discipline specific treatment data, type of service provider, and type of session. Frequency of therapy (calculated by taking the mean number of sessions per day). Duration of therapy (calculated by taking the mean number of minutes per therapy session).	Overall, low correlations were found between FIM™ scores and discipline specific frequency, duration, and intensity of therapy. There was a low, positive correlation between OT frequency and discharge FIM™ scores (r = .241, p = 0.031). Gender and type of stroke did not affect FIM™ scores.	Study did not look at relationship between therapy intensity/duration and FIM™ change – study focused on d/c FIM™ scores. Data obtained through record review. Patients were not subdivided by stroke severity.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Wang, H. et al. (2013). Daily treatment time and functional gains of stroke patients during inpatient rehabilitation. Journal of Injury, Function & Rehabilitation, 5(2), 122-128.	n = 360

Time since stroke onset:?

Functional Status/ inclusion criteria: patients 18 years or older, discharged from the IRH, with a LOS of 3 days or longer.

Excluded:? | Retrospective Cohort Design

Purpose: to look at the effects of daily treatment time on functional gain of patients post stroke. | OT, PT, and S-LP | The daily treatment durations were grouped as follows: average daily PT minutes were grouped into <1.5 hours, >1.5 but <2.0 hours, and >2.0 hours; average daily OT and S-LP minutes were grouped into <0.5 hour,> 0.5 but <0.75 hour, and >0.75 hour; and average daily combined treatment minutes were grouped into <3.0 hours,>3.0 but<3.5 hours, and >3.5 hours.

Duration of treatment or average daily treatment minutes was calculated by dividing the total minutes by LOS (except Sundays) for each type of treatment, as well as combined treatment. | Format or content of therapy was not tracked or described in this study. | FIM™ scores | Patients who received rehabilitation treatment >3 hours per day showed a significantly higher total FIM™ gain than those who received rehabilitation treatment <3 hours per day*.

Longer daily PT duration was associated with a greater gain in ADL, mobility, and total FIM™ scores. A longer daily OT or SLP duration was associated with a greater gain in ADL, cognition, and total FIM™ scores.

*After adjusting for age at IRH admission, gender, comorbidity index, and total cognition scores and total motor scores at IRH admission. | No treatment specifics recorded or stroke severity measures used.

Information obtained through chart review/ clinical database. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Systematic Reviews in OTHER settings								
Bhogal, S. et al. (2003). Intensity of Aphasia Therapy, Impact on Recovery. Stroke, 34, 987-993.	n = 864 (patients from 10 controlled trials) Time since stroke onset: ? Functional Status: Presence of aphasia Inclusion criteria: Studies including stroke survivors with aphasia where two different intensities of S-LP intervention were compared. Excluded: Studies which included those with TBI or other disorders.	Systematic Review Purpose: to investigate the relationship between intensity of aphasia therapy and aphasia recovery by examining clinical trials on aphasia therapy. Data abstracted from articles included treatment type, length of therapy period in hours and weeks, and mean change in scores for outcome measures.	S-LP & volunteers: varied in each study.	S-LP intervention, and in some cases volunteer involvement with patient. Positive studies provided an average of 7.8 hours of therapy per week for 18 weeks; negative studies provided on average 2.4 hours per week for 22.9 weeks. Average total number of hours of therapy was 109 in positive studies vs. 43.6 in negative studies.	Varied in each study.	Outcomes measured varied per study and included: Porch Index of Communicative Abilities (PICA), Token Test, Functional Communication Profile (FCP), Western Aphasia Battery, Language Quotient, Auditory Comprehension Test, and Aachen Aphasia Test.	More intensive therapies (over a shorter time frame) resulted in improved outcomes for persons with aphasia. Of the 10 studies reviewed, 5 were positive (speech and language skills improved) and 5 were negative (they did not improve). Positive studies showed significantly higher improvement on PICA and Token Test.	Several independent reviewers used; data abstractors blinded from results; articles were rated using PEDRO (with maximum score of 10). Only three of the studies rated using PEDRO were considered 'good' quality (a score of 6 or higher).

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Cherney. L. et al. (2008). Evidence Based Systematic Review: Effects of Intensity of Treatment and Constraint Induced Language Therapy (CILT) for Individuals with Stroke-Induced Aphasia. Journal of Speech, Language and Hearing Research, 51, 1282-1289.	n = not indicated (subjects from 10 studies)

Time since stroke onset: ?

Functional Status: 18 years or older with stroke-induced aphasia.

Inclusion criteria: studies of CILT or studies which compared higher to lower intensity treatment for aphasia.

Excluded: underlying cognitive deficits or other primary medical diagnosis. | Systematic Review

Purpose: to review studies with two different levels of S-LP provision and/or CILT and summarize any evidence for intensity of treatment.

Review aimed to explore 10 clinical questions; 15 databases searched. | S-LP: varied per study. | Varied per study.

5 studies on treatment intensity, 4 studies on Constraint Induced Language Therapy (CILT) and 1 study examining both. | Speech-language therapy and/or Constraint Induced Language Therapy.

Most studies provided 24-30 hrs of treatment.

Several studies reported 100 hrs or more of treatment.

Treatment schedules varied across studies as well as nature of treatment provided. | Varied per study. | Individuals receiving more intensive treatment showed greater gains on language impairment tasks than did the comparison individuals who received less intensive schedule (68 patients in total).

For studies that measured community activity/participation, five favoured more intensive treatment and 4 favoured less intensive treatment.

CILT led to positive outcomes on language impairment and measures of communication activity/participation. | Studies occurred in various settings and included subjects with acute and chronic aphasia.

Difference in outcome measures used limited comparison of results across studies.

Authors blinded to each other's results, independent reviewers used, and quality markers assigned based on AHA level of evidence. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Kwakkel, G. et al. (1997). Effects of Intensity of Rehabilitation After Stroke: A Research Synthesis. Stroke a Journal of Cerebral Circulation, 28(8),1550-1556.	n = 1051 (subjects from 9 RCTs) Time since stroke onset: ? Functional Status: ? Inclusion criteria: subjects were stroke patients, effects of different intensities of PT and/or OT were evaluated, true or quasi-experimental design, rehab outcomes measured in terms of ADL, study was published. Excluded:?	Systematic Review Purpose: to evaluate effects of different intensities of stroke rehabilitation provided by OT and PT. Methodological score assigned according to Postdam standards.	OT and PT: varied per study.	Each study had a treatment group and control group – one group was receiving a different intensity of OT and/or PT than the other in order to be included in the review. On average the intensive rehab group received daily almost twice as much PT and OT as the control groups.	OT and PT treatments – types may have varied in each study.	Varied per study.	Small but statistically significant improvement in ADL. Neuromuscular and functional outcome variables were found as a result of higher intensities of rehabilitation.	A difference in summary effect sizes was found between studies in which experimental and control groups were managed in the same setting compared to those where the groups were in different settings. The authors note that treatment days, frequency or amount of treatment are only rough indicators of therapy intensity.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Langhorne, P. (1997). Physiotherapy after stroke: more is better? Physiotherapy Research International, 1(2), 75-87.	n = 597 (patients from 7 RCTs) Time since stroke onset: ? Functional Status: ? Inclusion criteria: physiotherapy intervention was provided at greater intensity than the contemporary 'normal practice'. Excluded: trials which aimed to compare organizationally different stroke services or qualitatively different stroke services.	Systematic Review of RCTs. Purpose: to examine physiotherapy provided to stroke patients within qualitatively similar therapy regimes but where therapy was provided at different levels of intensity.	PT: varied per study.	Control groups represented normal practise with approx. 20-40 minutes of PT/day. Intervention patients received modest increase in therapy units (ca. 1.5-2 times control levels). Note: amount of therapy received by controls in some trials exceeded that of the treatment group in other trials.	Varied per study.	Case fatality, motor scores and ADL scores.	Pooled analysis suggests intensive physiotherapy may reduce impairment and disability but effect is transient and of limited scale. Author concludes there is inadequate information to allow informed decisions about the best level of physiotherapy input after stroke despite a trend towards improvement in ADL and impairment scores.	Some trials confounded by the organizational setting in which PT was delivered (intervention group managed in different setting than control group). In 5/7 trials the outcome assessor was blinded to treatment allocation.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)				Main Outcome Measures	Results	Comments
Lohse, K. et al. (2014). Is More Better? Using Metadata to Explore Dose-Response Relationships in Stroke Rehabilitation. Stroke, 45, 2053-2058.	n = 1750 (patients from 37 RCTs) Time since stroke onset: for treatment groups: 1.01 ± 1.49 years; for control group 1.02 ± 1.63 years. Functional Status:? Inclusion criteria: stroke patients; dosage was not matched for total time scheduled for therapy. Excluded: lacked randomization or control group; <18 years; disorder other than stroke; therapy combined with pharmalogical or electrical stimulation treatment; dose matched treatment and control groups; non-published & non-English articles.	Meta- analysis Purpose: to explore the relationship between time scheduled for therapy and improvement in motor scores by comparing high to low doses and to quantify the dose-response relationship .	Varied per study.	Varied per study; pooled duration of therapy in treatment group was 49.56 ± 68.12 days, and for control groups was 49.60 ± 68.10 days. Time scheduled for therapy treatment group was 57.41 ± 44.8 hrs and for control group was 24.08 ± 30.39 hrs. Average difference between both groups was 33.33 ± 36.20 hrs.	Varied per study.		Varied per study.	There is a small overall benefit of augmented therapy time. Positive dose-response relationship was found across studies rehabilitating different impairments and functions. There was a significant positive effect of time scheduled for therapy on outcomes even when controlling for time after stroke.	Limited to time scheduled for therapy instead of active time in movement practise or movement repetitions. With only 30 studies in the meta-regression, power was lost to detect any additional effects on interactions.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Verbeek, J. et al. (2011). Effects of Augmented Exercise Therapy on Outcome of Gait and Gait Related Activities in First 6 Months after Stroke. Stroke, 42, 3311-3315.	n = 725

(subjects from 14 RCTs)

Time since stroke onset: first 6 months post stroke

Functional Status: ?

Inclusion criteria: adult patients; within 6 months post stroke; experimental group spent more time in therapy than control group; outcomes defined as gait related or ADL related, moderate to high methodological quality.

Excluded: ? | Meta-Analysis of RCT's

Purpose: to determine if additional time spent in exercise therapies improved aspects of gait. Reviewed studies in which experimental group spent augmented time in lower limb exercise therapy compared to the control group. | PT and OT-search terms included exercise, physical therapy and rehabilitation. | Intervention period ranges from 2-20 weeks with frequency of 3 to 5 sessions/week.

Additional therapy time ranged from 270 to 3000 minutes.

Experimental groups spent approx. 37 minutes per working day in augmented exercise therapy during a mean of 5.7 weeks.

In all studies experimental group spent more time in lower limb exercise therapy compared to controls. | Therapies included: over ground walking, backwards walking, standing practise, treadmill training, functional strength training. | Results pooled for: Walking ability, comfortable and maximum walking speed, basic and extended ADL. | Patients with stroke benefit from additional time spent in lower-limb exercise therapy with regards to walking ability, walking speed, and extended ADL within the first 6 months after stroke. | Would need to go to original studies to determine where the therapies took place (? inpatient rehab or other settings).

Studies classified based on PEDRO scores.

Four major publication languages searched.

Studies with various training modalities were reviewed.

Not all studies reviewed used blinding of observers. |
| **Randomized Control Trials in OTHER settings** | | | | | | | | |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Askim, T. et al. (2010). Effects of a community-based intensive motor training program combined with early supported discharge after treatment in a compre-hensive stroke unit: a randomized, controlled trial. Stroke, 41(8),1697-703.

*also in Sehatzadeh HQO Rapid Review. | n = 62 patients

Time since stroke onset: 4 to 14 days

Functional Status / Inclusion Criteria: Modified Rankin <3, Berg Balance <45, Scandinavian Stroke Scale >14, MMSE >20, able to consent.

Excluded: unable to tolerate the motor training. | Single-blind, randomized, controlled trial with a 26-week follow-up.

Purpose: to evaluate effectiveness of community based intensive motor training (n=30) compared to standard treatment group (n=32). Secondary aim: to evaluate the functional effect. | Physical therapists provided additional motor training on top of standard care. Specially trained nurses offered training in ADL when appropriate. | The intervention group received 3 additional sessions of motor training each week for the first 4 weeks after discharge from the stroke unit and 1 additional session every week for the next 8 weeks.

Each session was intended to last from 30 to 50 minutes.

The patients were also encouraged to perform home exercises during this period. | Patients received 3 sessions of physical therapy and a structured home exercise program in addition to standard treatment every week for the first 4 weeks after discharge from hospital.

The treatment was administered in the patient's home, at a rehabilitation clinic, or at an out-patient clinic, depending on where the patients were discharged after their hospital stay. | Primary outcome measure was Berg Balance Scale.

Secondary measures were Barthel Index, Motor Assessment Scale, Step Test, 5-Meter Walk Test, and Stroke Impact Scale. | Doubling the amount of physical therapy during the first 4 weeks after discharge did not show significant improvement on balance or any other functional outcomes. | This was included in the Sehatzadeh HQO Rapid review (March 2013) – see reference list.

Not specific to inpatient rehabilitation setting. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Di Lauro, A. et al. (2003). A randomized control trial on the efficacy of intensive rehabilitation in the acute phase of ischemic stroke. Journal of Neurology, 250(10), 1206-1208. * also in Sehatzadeh HQO Rapid Review.	n = 60 Time since stroke onset: recent stroke (first two weeks post stroke). Functional Status: admitted to acute hospital with hemispherical ischemic stroke, age 40-80, with severe functional disability. Inclusion: hemiplegia, unimpaired consciousness, disability post stroke (Barthel Index ≥ 3). Excluded: cerebral hemorrhage, hemineglect, slight hemiparesis, sensorial aphasia, cardiac or respiratory disorders.	Randomized Control Trial Purpose: to compare stroke patients divided into two groups: intensive rehab treatment or standard rehab treatment over 14 days in the acute phase (followed by 60 days of rehab treatment at a rehab centre with same methods for both groups) and determine if initial treatment intensity provided better results on outcomes (as measured by Barthel Index).	Providers of treatment not identified in study.	Intensive therapy group received 2 hours per day (with 6 hours between the 2 treatment sessions) for 14 days. Usual care therapy group received 45 minutes per day for 14 days.	Intensive group received in the morning exercise of mobilization with 'active work' for 45 minutes, exercises for proprioceptive recognition, and rehabilitative nursing (15 minutes) In the afternoon this group received exercises for mobilization (15 min), tactile kinesthetic stimulation, visual stimulation, cognitive skill exercises, and acoustic stimulation (45 minutes). Usual care therapy included 45 minutes of passive and active mobilization, and corrective bed positioning.	NIH Stroke Scale, Barthel Index at baseline, 2 weeks and 6 months.	No significant difference between intensive therapy and usual care provided in first 14 days post stroke; differences were found at 2 weeks and 6 months. Both groups improved overall on the Barthel Index from 2 weeks to 6 months.	Authors query whether a group of less severely affected patients would have benefited more. Time frame for therapy provision was short (only 2 weeks). Setting is acute care.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Fang, Y. et al. (2003). A study on additional early physiotherapy after stroke and factors affecting functional recovery. Clinical Rehabilitation, 17(6): 608-17. * also in Sehatzadeh HQO Rapid Review.	n = 156 Time since stroke onset: ? Functional Status: ? Inclusion criteria: admitted to hospital within 1-week post stroke. Excluded: those with subarachnoid haemorrhage, TIA; Glasgow Coma Scale <8; affected limb power grade <3; premorbid dementia; infection present; severe high blood pressure (unable to tolerate 45 minute sessions).	Prospective Randomized Control Trial-computer randomization used. Purpose: to determine the effect of early additional PT intervention compared to control group on functional outcomes.	Two experienced PTs from the rehab unit treated the patients on acute and followed them onto the rehab unit.	Group 1: additional Early PT (AEP Group): 45 minutes, 5 days/week for 4 weeks, started first week after stroke. Group 2: routine therapy: no professional rehabilitation therapy.	Bobath techniques and passive movement training of affected limbs. Routine group received no professional or regular physiotherapy during the whole hospitalization period.	Modified Barthel Index done at baseline, 4 weeks and 6 months. Glasgow Coma Scale, MMSE, Fugl-Meyer Assessment of Motor Recovery, and Clinical Neurological Deficits Scale. Follow up assessment and outcome measures performed at 30 days and 6 months.	Patients in the AEP group made relatively better functional recovery at 30 days compared to those from the routine treatment group. No significant difference was found on the Barthel Index between groups at 4 weeks or 6 months.	Therapists blinded to patient groupings. High dropout rate for patients from the AEP group which weakened the results. Patients were treated on a 45-bed stroke ward and a 2-bed intensive care unit. Organization of units could have affected results.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Gilbertson, L. et al. (2000). Domiciliary occupational therapy for patients with stroke discharged from hospital: a randomised controlled trial. British Medical Journal, 320(7235), 603-6. * also in Sehatzadeh HQO Rapid Review.	n = 138 Time since stroke onset: median days after stroke was 23-31 days. Inclusion: admitted to hospital with plan for discharge to home. Excluded: those with severe cognitive or communication problems.	Single-Blind Randomized Control Trial. Purpose: to determine effect of increased in home occupational therapy provision on functional outcomes (ADL) and patient satisfaction compared to control group.	Occupational therapy	Control group (n=71): included pre discharge home visit, support service and equipment, and regular multidisciplinary team review; some select clients were referred to the medical day hospital. Intervention group (n=67): ten visits lasting 30-45 minutes, and tailored to the patients' goals.	Domiciliary OT group: received OT treatment in home for 6 weeks. Routine follow up group: received routine services.	Nottingham extended activities of daily living score Barthel Index Patient satisfaction survey Hospital readmissions	Patients in the intervention group reported greater satisfaction across all 12 questions. However, there was no significant difference at baseline, 8 weeks or 6 months on Barthel Index scores between the groups. Results do lend support to extending routine stroke rehabilitation from the inpatient period to the post discharge period.	Treatment provided in home. Outcome assessor was blinded to the treatment allocation. Small study size.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Godecke, E. et al. (2013). Amount of Therapy Matters in Very Early Aphasia Rehabilitation after Stroke: A Clinical Prognostic Model. Seminars in Speech and Language, 34(4), 129-141.	n = 59 Time since stroke onset: up to 4 weeks post stroke. Functional Status/ Inclusion criteria: Acute stroke; medically stable; remains awake for >30 minutes; scores less than 9.8 on Aphasia Quotient (AQ) of the Western Aphasia Battery (WAB). Excluded: those with previous diagnosis of aphasia; history of mental illness.	Secondary analysis from 2 randomized single-blind control trials conducted in Australian acute and sub-acute hospitals. Purpose: to compare daily S-LP therapy to ward care and daily S-LP group therapy to S-LP individual therapy.	Speech-language therapists	Treatment was provided in 21-51 days post stroke. Intensity and frequency differed from Study 1 to Study 2. Those in Study 1 received 365.75 hours of therapy over 373 sessions (mean was 18.65 sessions).	Study 1: compared daily therapy to usual ward care for up to 4 weeks post stroke. Therapy included lexical semantic therapy, mapping therapy, and semantic feature analysis Study 2: Compared daily group therapy to daily individual therapy for 20 1-hour sessions over 5 weeks. Group therapy was constraint-induced language therapy.	WAB Regression modelling to look at effects of age, baseline AQ, Modified Rankin Scale, average amount of therapy, therapy intensity, and number of therapy sessions. Therapy time recorded using Allied Health System software.	Amount of treatment received was a significant predictor of recovery. This model demonstrated that an anticipated rise in AQ scores can be expected with increasing number of minutes of therapy provided (no therapy to 30 minutes to 60 minutes) and this is above and beyond what would be expected with spontaneous recovery. 29% of subjects who received no direct aphasia therapy in first 22 days still made change in AQ scores which can be attributed to spontaneous recovery.	Treating S-LPs were blinded to group allocation.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Han, C. et al. (2012). Effects of intensity of arm training on hemiplegic upper extremity motor recovery in stroke patients: a randomized control trial. Clinical Rehabilitation, 27(1), 75-81.	n = 32 Time since stroke onset: Mean days post stroke ranged from 38.30 to 42.90. Functional Status: stroke patients with first ever stroke of MCA territory, impaired motor arm function, able to tolerate the intervention, age 25-80. Excluded: excessive spasticity(>3 Modified Ashworth Scale), excessive pain.	Randomized Control Trial Subjects were randomly divided into three groups: each group received arm training 5 days per week for 6 weeks for 1, 2 or 3 hours. Purpose: to determine effect of three different intensities of arm training on UE functional recovery.	Study did not indicate which profession provided the treatment.	All groups received arm training 5 days per week for 6 weeks. Group A : one hour Group B: two hours Group C: three hours After 6 weeks, total length of time spent in arm training was 30 hours (group A), 60 hours (group B) and 90 hours (group C).	Not indicated	Fugl-Meyer Assessment (FMA), Action Research Arm Test (ARAT), and Barthel Index	A weak dose-response relationship was found between intensity and change in functional recovery. After 20 hours of training, groups were similar. However, after 40 hours of training, effects began to show with improved UE motor function. FMA improvement was more significant in group C than in group A or B after 4 and 6 weeks. ARAT score improvement was more significant in group C at 6 weeks. No significant difference in Barthel Index was found amongst the three groups. All groups improved overall from baseline.	Small sample size means study is underpowered and requires larger sample sizes to verify results. Therapy providers not defined. Does not indicate if treatment was provided in acute or rehabilitative setting (patients admitted to Qingao University Medical Hospital).

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Lincoln, N. et al. (1999). Randomized controlled trial to evaluate increased intensity of physiotherapy treatment of arm function after stroke. Stroke, 30, 573-579.	n = 282 Time since stroke onset: between 1-5 weeks post stroke. Functional Status/ Inclusion criteria: referred to PT; planned discharge within 7 days; able to feed self and wash face pre-stroke; no premorbid dementia; English speaking; able to tolerate treatment; impaired arm function present post stroke; able to consent Excluded: those that scored 12 or more on arm function scale of Rivermead Motor Assessment (RMA).	Single-Blind Randomized Control Trial Patients randomly allocated to 1 of 3 treatment groups. Purpose: to determine if increased PT early after stroke improved arm function and to determine the effect of therapy if treatment was provided by the qualified therapist vs. assistant. Intervention of standard PT: specialized facilitated functional rehab (with PT) or active and passive ROM (with PTA).	PT and PTA.	Group1: routine PT with 30-45 minutes per day. Group 2: standard PT with additional 2 hours per week by senior PT. Group 3: Assistant physiotherapist group received standard PT and 2 hours per week of additional treatment by PTA.	Group 1: standard PT using mainly Bobath approach. Group 2: specialized facilitation functional rehab; patient encouraged and taught to practice correct movements by experienced senior therapist. Group 3: assistant provided passive, assisted and active movements, instruction on care of arm and positioning, and practise of functional activities.	RMA, Action Research Arm Test, Ten Hole Peg Test, Grip Skill (dynamometer), Motor Club Assessment (subtests), Modified Ashworth Scale, Ritchie Articular Index, Nottingham Sensory Assessment, and Barthel Index.	10 hours of additional physiotherapy for the upper limb showed no detectable benefit in acute stroke patients in their upper limb motor function or ADL ability, regardless of who (PT or PTA) provided the treatment.	91 patients in the additional therapy groups unable to tolerate that amount of treatment. Heterogeneous group in which most patients in the study were severely affected (i.e. only 34 had a score >1 on the RMA). Only 1 PT and 1 PTA administered the therapies.

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)			Main Outcome Measures	Results	Comments
Inception Cohort Studies in OTHER setting								
Bode, R. et al. (2004). Relative Importance of Rehabilitation Therapy Characteris-tics on Functional Outcomes for Persons with Stroke. Stroke, 35, 2537-42.	n = 228

Time since stroke onset: range of 5-58 days post stroke.

Functional Status: >18 yrs. of age, first stroke, receiving multidisciplinary inpatient rehabilitation in an acute or subacute setting.

Excluded: those with atypical LOS (<1 week, >8 weeks). | Observational Study using data from 2 previous multicentre studies.

Purpose: to compare function-focused therapies to impairment-focused therapies provided by PT, OT and S-LP and to determine their effect on functional outcomes. | PT, OT and S-LP. | Function-focused therapy vs. impairment- focused therapy recorded in units provided per day (1 unit = 15 minutes). | OT, PT and S-LP provided therapies, which were classified into 5 areas: evaluation and screening, function-focused activities, impairment-focused activities, discharge planning, and case management. | FIM™

Units of time spent by OT, PT and S-LP in 71 pre-identified therapy activities. | Longer stays and more intense function-focused therapy were associated with greater than expected gains in self-care and mobility.

Dose-response effect was observed - more therapy was related to greater than expected gains.

Time spent in impairment focused activities was not associated with greater than expected improvement.

More impaired persons received more function-focused therapy. | Self-selection may have created bias. |

Reference	Sample	Design & Purpose	Underlying Components of Rehabilitation Intensity (Methods)		Main Outcome Measures	Results	Comments
Observational Study or Retrospective Chart Review in OTHER setting							
Wodchis, W.P. et al. (2005). Skilled nursing facility rehabilitation and discharge to home after stroke. Archives of Physical Medicine & Rehabilitation 86(3), 442-448.	n = 23,824 Time since stroke onset: ? Functional Status/ inclusion criteria: residents of Skilled Nursing Facilities in the US or Complex Continuing Care Units in Ontario; patients age 65 or older; patients previously residing in the community. Excluded: those with terminal prognosis; hip fracture in past 180 days; missing data or more than 1000 minutes of weekly therapy.	Retrospective Cohort Design, which used regression analyses; stratified by expected outcome with propensity score adjustment. Purpose: to examine different levels (in terms of number or range of minutes) of rehab therapy provided and effects on discharge destination.	Total weekly minutes of rehab therapy (RT) (the sum of physical and occupational therapy) provided to residents.	Weekly RT minutes divided into 5 categories: no therapy 1-175, 176-329, 330-499, 500+ minutes.	Not indicated.	Discharge home LOS	Rehab Therapy increased the likelihood of discharge to community for all groups except those expected to be discharged within 30 days. The dose-response relationship was strongest for stroke patients with an uncertain discharge or no discharge expected. No significant dose response was found for residents either with a discharge expected within 30 days or between 31 and 90 days. For residents with an uncertain prognosis, increased RT intensity was positively and significantly associated with an increased likelihood of discharge home.	

Discussion

Inpatient Rehabilitation:

There were 16 articles that matched the inclusion criteria and were specific to provision of, or comparison of provision of, intensity to stroke patients in the inpatient rehabilitation setting. This included five Level 1, seven Level 2 and four Level 3 articles. (Adapted from Oxford Centre for Evidence-Based Medicine, 2011 Level of Evidence: questions 3 and 4).

Level 1: From the systematic review, meta-analysis or RCT studies reviewed, three focused on PT provision. Of these one favoured increased intensity provision (for improving gait), one showed no significant difference between groups and one showed significant gains in the high intensity group in the short term, which were not maintained at a later follow up (4 weeks vs. 6 months). No studies focused on OT or S-LP specifically. One study looked at OT and PT provision combined at two different intensities and found the group receiving more therapy had improved outcomes. The last study did not indicate which professions provided the therapies and found small statistically significant improvements for the higher intensity leg training group in the short term (at 20 weeks) but these gains were not held over the long term (at 38 weeks or 1 year).

Level 2 & 3: The inception cohort and observation studies or retrospective chart review studies demonstrated a tendency to have results that favoured increased RI provision (results showed that increased duration or frequency of therapy provision was related to either improved functional outcomes or decreased LOS) compared to the randomized control trials. In total 11 of these studies showed results where provision of higher intensity therapies led to either better functional outcomes or shorter LOS in rehabilitation. Interesting to note is that all of these studies looked at combined provision of OT, PT and S-LP – which mirrors how therapy is generally provided in a 'real life' clinical environment. This is perhaps more in line with stroke best practices which support having occupational therapists, physiotherapists and speech-language therapists along with other key professionals involved in providing therapy and stroke care in an interprofessional manner (Canadian Best Practices for Stroke Care, 4th edition, 2013).

Other Settings:

In terms of studies focused on Rehabilitation Intensity provision comparisons in a non- inpatient rehabilitation setting, we found 15 studies that were carried out in various or other settings or where the setting of the study was not clear. Of these studies three were conducted in the community setting, one in the acute setting, one started in the acute setting and followed patients to inpatient rehabilitation, two included patients in a facility that had both acute and sub-acute stroke care, and one study was undertaken in a skilled nursing facility setting. In seven studies the location was not specifically identified or could have been in various settings due to the study being a systematic review or meta-analysis (four in total). Overall there were thirteen Level 1 studies, one Level 2 study and one Level 3 study. From the systematic review, meta- analysis or RCT studies, four of these focused on PT provision (three showing no significant difference between two levels of intensity provision and one systematic review favoured more intensive PT treatment). One study focused solely on OT provision showed no significant differences between groups. Three focused on S-LP provision and all favoured more intensive provision of S-LP therapies. Five studies focused on multiple providers or it was unclear which providers were providing which treatments. Of these five studies, three were in favour of higher intensity rehabilitation provision (including two systematic reviews and one meta-analysis), one demonstrated unclear results and one found no difference between groups.

From all the studies (31 in total) 20 included data or results which favoured increased RI provision in some way and which authors commented on in their results or discussion section – but these results were not always statistically significant.

Overall there seems to be particular difficulty in conducting large randomized control trials with this population using specific criteria and with samples large enough to produce significant power to detect more moderate changes in function. Common issues were: assessors were not blinded to the groups subjects were assigned to; assessors were also those providing the intervention; sample sizes were small; and organizational setting or set up may have confounded results. We found the Functional Independence Measure™ (FIM) instrument was widely used throughout the research reviewed as a tool for measuring functional changes. Patient experience or achievement of patient specific goals was not measured in any of these studies, although some did use satisfaction surveys. In terms of being patient-centered, future research may want to focus on achievement of patient goals as a more appropriate measure of whether or not a given therapy or intensity of therapy has done a good or better job at reaching its target. This would provide a patient-centered lens to the need for increased RI (or not) instead of a system-centered one. Finally, several studies looked at the amount of time or frequency of therapy provision (and/or differences between groups) but did not provide information on the content of the therapy provided within these time frames. This would make reproducing these studies difficult and still leaves the question open: Is it what is provided or how often or how intensely it is provided that really matters?

Conclusions and Next Steps

From our review of inpatient rehabilitation studies there were 5 Level 1 studies and 4 of them demonstrated short term positive effects of higher intensity rehabilitation. Unfortunately there is less evidence to support longer terms benefits of increased Rehabilitation Intensity. Given the limited number of high quality, large randomized controlled rehabilitation trials we considered Level 2 and Level 3 evidence. In these cohort and large sample observational studies there is compelling evidence to support the benefits of higher intensity rehabilitation. Level 1 evidence (best level of evidence) indicates there is inconclusive evidence that increased participation in or provision of occupational therapy, physiotherapy, speech-language pathology therapies improve functional outcomes and/or reduce LOS as well as improve chances of discharge to home in adult stroke survivors treated within an inpatient active rehabilitation setting. When we expand our research into Level 2 and Level 3 studies we find more evidence that providing higher intensity of OT, PT and/or S-LP therapies can improve functional outcomes and/or reduce LOS. While lack of randomized design does affect the rigour of the research, carrying out studies in a real world clinical environment or performing chart review is sometimes necessary for ethical or practical reasons or to be able to perform research on a larger sample. Therefore, this research should not be discounted, but the inherent issues with non RCT studies needs to be taken into account when considering the results of these studies.

Finally, while this research resource is useful, individual organizations may need to also evaluate their own data in order to determine what staffing, resource or process changes can create the best outcomes in terms of improving on or providing the best stroke rehabilitation care possible while remaining fiscally responsible.

Future research in this area may endeavour to look at the impact of multidisciplinary approaches to increased Rehabilitation Intensity, examine if the content of therapy received by stroke patients has as a greater or equal effect as time spent in receiving therapy, as well as expand our understanding of not only the link between Rehabilitation Intensity, LOS and/or FIM™ efficiencies but also its effect on stroke patients goal achievement and patient experience.

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